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Computed Radiography Basics

Overview

Computed Radiography is a term used to describe a system that electronically records a radiographic image. Computed Radiographic systems use unique image receptors to capture an analog image and sophisticated readers to process the image and convert the information into a digital format. Since Computed Radiography (CR) utilizes digital technology, images may be electronically manipulated to adjust contrast and density. The computer-generated images obtained with CR can be displayed using electronically and/or on film.

Historical Perspective

Electronic imaging technologies and image management systems offer the capabilities to attain needed efficiencies. Many digital imaging technologies are presently utilized such as Computed tomography (CT) and diagnostic medical sonography, however, general radiography (a predominantly analog process), represents 60 - 80% of all diagnostic radiography examinations. To meet this need, Computed Radiography was introduced in 1981 by FUJIFILM at the International Congress of Radiography in Brussels and at the Radiological Society of North America in Chicago. The FCR 101 was the first available clinical system and was released in 1983.

However, widespread adoption of Computed Radiography lagged behind other computer-driven modalities, primarily because digitization of analog data produced reductions in the quality and quantity of information. As such, technological improvements were needed to meet the quality standards essential for the performance of highly detailed, general radiographic examinations. Subsequently, Fuji focused on CR system improvements in key clinical areas: Improved processing speed, higher spatial resolution, reducing patient exposure, and the augmentation of data storage and transmission to provide timely retrieval and communication through the use of industry standards such as DICOM.

What is a Digital Image?

Digital images are described in terms of numeric values displayed in an array of rows and columns or Pixels (picture elements); this array of pixels is termed a Matrix. The pixel is the smallest component of the matrix and the quantity of information in each pixel is determined by the number of bits (binary digits) of information per pixel. Corresponding to a specific anatomical location, each pixel represents the x-ray intensity by a numeric value corresponding to a particular area on the image.

Introduction to Fuji Computed Radiography (CR)

Computed Radiography (CR) refers to the use of Photostimulable Storage Phosphors (PSP) for projection of X-ray imaging. In lieu of conventional screen/film, an imaging plate (IP) is used within a specially designed cassette.

Imaging Plate

The IP is comprised of multiple layers. The top layer is a **protective layer** and is a thin, transparent layer used to guard against damage caused by handling. The **photostimulable phosphor layer** serves as the functional layer of the IP by storing energy absorbed from the x-ray exposure. Information obtained through the initial stimulus or primary excitation (x-ray exposure) is stored in the phosphor and later "read out" when light or a secondary stimulus is applied to the phosphor layer. This phenomenon is called a photostimulable luminescence and makes energy storage possible within the crystal. The phosphor layer is comprised of barium fluorohalide in combination with a small amount of europium**.** The europium acts as an activator replacing some of the barium atoms and creating a "luminescence-center" in the crystal that becomes ionized by the incident radiation and is the site where energy (information) is stored as a latent image. The latent image is formed within the crystal following the transfer of energy by a photoelectric interaction. During image processing, a secondary stimulation created by a laser beam scan of the IP causes the crystal to emit blue-violet light proportionate in intensity to the x-ray energy absorbed. The **electroconductive layer** provides a certain amount of flexible rigidity to the IP; it also protects the phosphor layer from extraneous forces and shocks. There are additional **support** and light **shielding layers** added for additional protection and to inhibit reflection of the laser light. For some plate types, a **backing layer** is employed, and a **barcode label** is attached to identify each imaging plate. For Dual Side reading FCR devices, the shielding and backing layers are replaced with a **transparent backing layer** that allows for the collection of PSL from both sides of the IP simultaneously.

Imaging Plates synopsis:

- The IP is used to capture the image
- It is very important to note that the IP is more sensitive to all types of radiation than conventional intensifying screen phosphors.
    - Direct
    - Scatter
    - Natural Background Radiation

Ambient radiation can increase mottle, lower contrast, and have an affect on image quality. Any IP not used within 48 hours should be erased before use. The IP is housed within a special cassette that looks very similar to a conventional screen/film cassette.

- Latches
- Barcode Window
- A green stripe is on the tube-side as reference guide for image orientation.

CR Imaging Process

1. Using standard X-ray equipment, the IP (within the cassette) is exposed. The x-ray photons pass through the subject and strike the IP to form the latent image.

2. The IP is typically bar-coded at an Image and Information Processing (IIP) station to ensure proper processing.

3. The Cassette is then inserted into the CR Reading Unit and the IP is mechanically removed for processing.

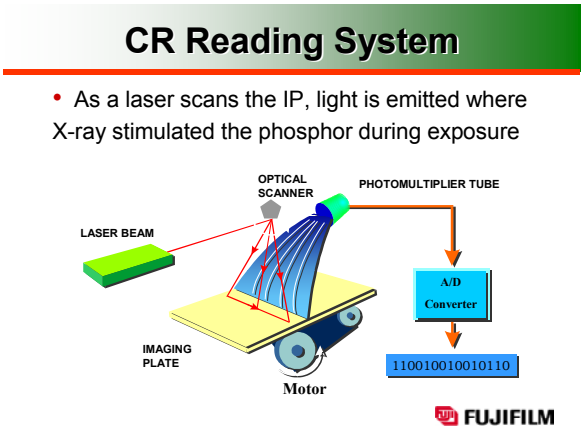
4. The IP is transported through the system where it is scanned by a laser beam. The stored energy is released from the IP in the form of light, known as Photostimulable Luminescence (PSL).

5. The PSL is collected and passed through a photomultiplier, then converted to a digital signal.

6. A data recognition processes occur to meet the specified diagnostic need. The signals are reconstructed for output with a specified set of image processing parameters applied. The image can be sent to another Computer and/or Laser printer.

7. After the readout and image processing is completed, the IP is exposed to high intensity light erasing any latent image.

8. The IP is then returned to the cassette, ready to be used for another image acquisition.



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Fuji Computed Radiography FAQs

Question: Why are we switching to Computed Radiography (CR)?
Answer: CR has been shown to improve department efficiency and workflow, reduce image retakes due to exposure errors, and is a key technology enabling the adoption of PACS.

Question: What is the System Speed of FCR?
Answer: FCR should be considered a multi-speed system. The imaging plate employs a linear capture of exposure exceeding the capabilities of film/screen systems. FCR is not density or contrast limited but is noise limited.

Question: Can I use the same techniques as before?
Answer: For some exams the exposure factors will be the same. This is highly dependent on the currently deployed film/screen system speed.

Question: Can I continue to use phototiming with FCR?
Answer: Yes. A requirement for the use of phototiming with FCR is that calibration must be completed before using CR Cassettes and Imaging Plates. When a phototimer is used, the resulting mAs can change depending upon the type of cassette and detector (due to the absorption and backscatter characteristics of the cassette/detector). As the density of the image is controlled by the FCR processing, this calibration must be completed as described in the "Fuji CR Users Guide"

Question: Can I acquire multiple images on the same Cassette/IP?
Answer: Yes*. Collimated borders are detected as part of the Exposure Data Recognizer (EDR) processing. For best results, the collimated borders should be sharp and well defined. This ensures that unnecessary information, such as scatter; outside the collimated edges will be eliminated from the analysis. This process is often referred to as PRIEF (Pattern Recognizer for Irradiated Exposure fields). See the "CR Users Guide" for guidelines in exposure patterns.

Note* when delivering images to PACS, multiple images obtained on a singe cassette will limit the individual control of image enhancements and must be taken into consideration. For that reason, many facilities that have employed PACS prefer that only one image is acquired per cassette/IP.

Question: What is the significance of the **green** stripe on my CR cassettes?
Answer: The **green** stripe is used as a reference for image orientation and should be placed at the cephalic/top of the image in the portrait orientation. For landscape orientation (crosswise) the **green** stripe should be toward the patient's right side. Incorrect image orientation should be corrected prior to sending images to PACS or the Laser Printer.

Question: What is the significance of the "S" number?
Answer: The Sensitivity number, so-called "S" number is an indicator of the Photostimulable Luminescence (PSL) given off by the imaging plate (IP) while being scanned by the laser. The values are inversely proportional to the amount of radiation that strikes the IP.

Question: What is the significance of the “L” value?
Answer: The Latitude value, so called “L” value is as important as the “S” number when critiquing a CR image. For most clinical imaging, “L” values typically range between 1.6 and 2.3. When “L” values are outside this range, the result can also be an abnormal “S” number.

Question: Is radiation exposure the only factor that affects the “S” number?
Answer: No. The following factors can affect the “S” Number:

- Scatter
- Positioning and centering.
- Distance – SID and OFD
- Proper use of Grids
- Collimation
- Improper Exam selection at the IIP
- Failure to erase IP if it has not been used for 48 hours or longer
- Delay in processing from time of exposure

Question: If my “S” number is out of the recommended range, should I change it to be within the recommended range?
Answer: In mostly cases it is NOT recommended. The “S” number should not be altered unless the image data is compromised due to an over correction of the Exposure Data Recognizer (EDR). For example, this can occur when the “S” number goes below 25 and “L” number is greater than 2.0. These images typically appear completely whitened out after the EDR is applied, however the image details were present during the initial plate reading.